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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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EXAMINER

FOONG, SUK SAN

ART UNIT PAPER NUMBER

2823

DATE MAILED: 05/08/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/910,914

Applicant(s)

AHN ET AL.

Examiner

Suk-San Foong

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☐ Responsive to communication(s) filed on ____.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-30 is/are pending in the application.
- 4a) Of the above claim(s) ____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) ____ is/are allowed.
- 6) ☒ Claim(s) 1-30 is/are rejected.
- 7) ☒ Claim(s) 4 is/are objected to.
- 8) ☐ Claim(s) ____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on ____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on ____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. ____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☐ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) ____
- 4) ☐ Interview Summary (PTO-413) Paper No(s). ____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other:

Election/Restrictions

1. Applicant's election without traverse of Group II, claims 1-30, in Paper No. 5 is acknowledged.

Claim Objections

2. Claim 4 is objected to under 37 CFR 1.75(c), as being of improper dependent form for failing to further limit the subject matter of a previous claim. Applicant is required to cancel the claim(s), or amend the claim(s) to place the claim(s) in proper dependent form, or rewrite the claim(s) in independent form. Claim 1 requires the step of claim 4 in lines 3-4.

Claim Rejections - 35 USC § 112

3. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

4. Claims 1 and 2 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

5. Claim 1, it is unclear what is recited through the use of "directly patterning".

6. Claim 2 contains the trademark/trade names SiLK, and NANOGLOSS. Where a trademark or trade name is used in a claim as a limitation to identify or describe a particular

material or product, the claim does not comply with the requirements of 35 U.S.C. 112, second paragraph. See *Ex parte Simpson*, 218 USPQ 1020 (Bd. App. 1982). The claim scope is uncertain since the trademark or trade name cannot be used properly to identify any particular material or product. A trademark or trade name is used to identify a source of goods, and not the goods themselves. Thus, a trademark or trade name does not identify or describe the goods associated with the trademark or trade name. In the present case, the trademark/trade names are used to identify/describe low dielectric constant layer and, accordingly, the identification/description is indefinite.

7. The use of the trademark SiLK and NANOGLOSS has been noted in this application. It should be capitalized wherever it appears and be accompanied by the generic terminology.

Although the use of trademarks is permissible in patent applications, the proprietary nature of the marks should be respected and every effort made to prevent their use in any manner which might adversely affect their validity as trademarks.

Claim Rejections - 35 USC § 103

8. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

9. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

10. Claims 1-6, 9, 10-13, 15, 16, 17-20, 23-27, 29, and 30 are rejected under 35 U.S.C. 103(a) as being unpatentable over Jiang et al. ('880) in combination with Lopatin et al. ('954) and Applicant's Admitted Prior Art (AAPA).

Jiang et al. teach the method of forming copper interconnect layers for semiconductor devices which includes forming an interlevel dielectric 102 (ILD) and intermetal dielectric 104 (IMD) layers comprise of same or differing low-k material such as hydrogen silsesquioxane (Paragraph [0018]), etching trench 120 in IMD 104 (Paragraph [0019]), then depositing barrier layer 106 by atomic layer deposition on the surface of IMD 104 and trench 120 (Fig. 2C), depositing copper layer 110 over trench 120 and IMD 104 (Fig. 2D), and removing portions of the copper layer 110 and barrier layer 106 by CMP (Paragraph [0024]).

Jiang et al. do not list methylsilsesquiazane as one of the low-k dielectric materials and do not teach patterning low dielectric constant layer to form openings.

AAPA discloses the method of forming low dielectric constant copper interconnects which includes patterning low dielectric constant layer, methylsilsesquiazane with dielectric

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constant of 2.7, through electron beam (EB) and/or ultraviolet (UV) irradiation and further developed by tetra-methyl-ammonium hydroxide (TMAH) to form vias (Instant page 8, line 13 to Instant page 9, line 11).

It would have been within the scope to one ordinary skill in the art to combine AAPA's process of patterning and developing low dielectric constant layer using EB or UV irradiation and TMAH, respectively, with the process of Jiang et al. to enable the step of forming openings through the low dielectric constant layer in order to eliminate both photoresist and dry etching process steps.

Jiang et al. do not disclose that the barrier layer is formed using tungsten nitride (WN).

In regard to claims 10 and 24, Jiang et al. do not teach depositing copper layer by chemical vapor deposition.

Lopatin et al. teach the method of forming metal interconnect which includes providing trench region 220 (Figs. 2 and 3) in low dielectric constant layer (Col. 5, lines 37-39), then forming tungsten nitride barrier layer 401 over trench region 220 (Col. 5, lines 20-25) using ALD (Col. 4, lines 31-32) at a temperature between 373°K to 673°K (Col. 4, lines 42-45), forming copper pre-seed layer 402 (Col. 5, lines 41-45, and Col. 6, lines 6-10), then forming copper seed layer 403 (Col. 6, lines 30-54), then depositing copper layer 404 by chemical vapor deposition (Col. 6, lines 63-65), and removing excess copper layer 404, seed layer 403, pre-seed layer 402 and barrier layer 401 through CMP (Fig. 9, and Col. 6, lines 65-67).

It would have been within the scope to one ordinary skill in the art to combine Lopatin et al.'s process of forming tungsten nitride barrier layer with the process of Jiang et al. to enable the

step of forming barrier layer comprise of tungsten nitride material in trench 120 to provide excellent adhesion to the underlying low dielectric material (Col. 5, lines 37-39).

It would have been within the scope to one ordinary skill in the art to combine the teachings of Lopatin et al. and Jiang et al. to employ the step of using chemical vapor deposition for depositing copper layer in trench and via in the process of Lopatin et al. with the process of Jiang et al. to enable the step of depositing copper layer 110 by chemical vapor deposition over trench 120 and IMD 104 to be performed.

In regard to claims 11-13, and 25-27, Jiang et al. do not disclose the steps as recited in claims 11-13, and 25-27 during copper deposition.

AAPA teaches the method of depositing copper layer in trenches which includes selectively depositing copper using chemical vapor deposition technique to form metal interconnects at a temperature range 300°C-400°C in an atmosphere of pure hydrogen or argon from β -diketonate precursor bis(6,6,7,8,8,8-heptafluoro-2,2-dimethyl 1-3,5-octanedion) copper (II). (See Instant page 11, line 22 to Instant page 12, line 11).

It would have been within the scope to one ordinary skill in the art to combine both teachings because it would enable the step of depositing a copper layer to be performed.

11. Claims 7, 8, 21, and 22 are rejected under 35 U.S.C. 103(a) as being unpatentable over Jiang et al. ('880) in combination with Lopatin et al. ('954) and Applicant's Admitted Prior Art (AAPA) as applied to claims 1-6, 9, 10-13, 15, 16, 17-20, 24-27, 29 and 30 above, and further in view of Farrar ('931).

Jiang et al. do not teach forming low dielectric constant layer to a thickness of about 6,000 Angstrom to 20,000 Angstroms.

Farrar discloses the method of forming trenches and vias from low dielectric constant materials which includes providing metal layer 52 as lower metal interconnect layer (Paragraph [0034]), sequentially depositing low dielectric constant layer 55 and another low dielectric constant layer 57 (with both having dielectric constants lower than 4.0) by using spin coating process to a thickness of about 2,000 Angstrom to 15,000 Angstrom (Paragraphs [0036]-[0038]), subsequent forming via 65 and trench 67 (Fig. 12), forming barrier layer 72 in via 65 and trench 67 (Fig. 13, or Paragraph [0045]), then depositing copper 80 to fill in both via 65 and trench 67 by CVD (Paragraph [0048]), and removing copper 80 above the surface of layer 57 by CMP.

It would have been within the scope to one ordinary skill in the art to combine the teachings of Farrar and Jiang et al. to employ the process of Farrar to perform the step of forming low dielectric constant layer through spin coating with a thickness of about 2,000 Angstrom to 15,000 Angstrom with the process of Jiang et al. to enable the step of forming low constant dielectric layers 102 and 104 to be performed in order to eliminate etch stop layers and reduce the number of fabrication steps.

Claims 14, and 28 are rejected under 35 U.S.C. 103(a) as being unpatentable over Jiang et al. ('880) in combination with Lopatin et al. ('954) and Applicant's Admitted Prior Art (AAPA) as applied to claims 1-6, 9, 10-13, 15, 16, 17-20, 24-27, 29, and 30 above, and further in view of Gross ('083).

Jiang et al. do not teach forming copper layer using electroless deposition.

Gross discloses the method of forming copper interconnects which includes providing interconnect channels or trenches through low dielectric constant layer (Col. 1, lines 59-64), depositing diffusion barrier (Col. 2, lines 29-32), and then using electroless plating to depositing copper layer into trenches (Col. 2, lines 11-14).

It would have been within the scope to one ordinary skill in the art to combine both teachings to employ Gross' process of using electroless plating depositing copper layer in trenches in the process of Jiang et al. to enable the step of depositing copper layer 110 in trench 120 using electroless plating to be performed in order to lower the cost of production.

Conclusion

12. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Suk-San Foong whose telephone number is 703-305-0383. The examiner can normally be reached on Monday to Friday.


If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Wael Fahmy can be reached on 703-308-4918. The fax phone numbers for the organization where this application or proceeding is assigned are 703-308-7722 (7724, 3431, 3432).

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

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May 3, 2002


George Fourson
Primary Examiner
Art Unit 2823